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Ocean Observing: Serving Stakeholders in the Pacific Islands

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Ocean Observing: Serving Stakeholders in the Pacific Islands

AUTHORS

Melissa M. Iwamoto

Fiona Langenberger

Pacific Islands Ocean Observing System and School of Ocean and Earth Science and Technology, University of Hawaii at Manoa

Chris E. Ostrander

School of Ocean and Earth Science and Technology, University of Hawaii at Manoa

Introduction

Ocean and coastal observing systems around the world are designed to improve on-the-ground decision making by providing scientists, resource managers, industry, conservationists, recreationists, and the general public with relevant ocean data and information. While the need for improved ocean and coastal data and information is global, stakeholder decision making is often highly localized. Thus, information on stakeholder needs must be identified at local levels in order to effectively aid decision making.

To this end, 11 regional associations (RAs), comprising the coastal component of the U.S. Integrated Ocean Observing System (IOOS®), contribute to the national effort to provide an “eye on our oceans, coasts, and Great Lakes.” The needs of local stakeholders guide RA priority setting and strategic planning, resulting in a diverse set of observations, models, tools, and services among regions. The IOOS Program Office, based within

ABSTRACT

Operating an ocean observing system in a region as vast and diverse as the Exclusive Economic Zone of the U.S. Pacific Islands poses common and unique challenges that require tailored solutions. In order to address stakeholder needs for ocean data and information in a cost-effective and impactful manner, the Pacific Islands Ocean Observing System (PacIOOS) functions under a framework of stakeholder-driven priority setting. This strategy employs an innovative categorization of stakeholders into four general categories for the purpose of delineating levels of engagement: (a) data super users, (b) industry and natural resource managers, (c) informed public ocean users, and (d) the general public. Stakeholder needs are continuously gathered through many avenues, including staff dedicated to communications and engagement throughout the region and a higher-level governance framework composed of signatory partners. Principles of degree of need and potential for positive impact are utilized for prioritization. Although PacIOOS cannot engage with all stakeholders in the region, the approach taken to identify, engage, and respond to stakeholders serves as an effective and efficient method to ensure that both specific ocean stakeholders and stakeholders, writ large, benefit from the resources and efforts expended to advance ocean observing in the region. Two case studies from separate geographies and components of the PacIOOS program illustrate the value of this stakeholder-driven approach to users in the region. This approach may serve as a model for how to effectively address stakeholder needs and improve decision making through a regional ocean observing system.

Keywords: ocean observing, stakeholder engagement, Pacific Islands, inundation

the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA), and the nongovernmental IOOS Association identify and support common goals and overarching priorities across the regions. The focus of this manuscript is how the Pacific Islands Ocean Observing System (PacIOOS), the first RA to be certified as a full member of IOOS (Ostrander & Lautenbacher, 2015), plans and operates under a framework of stakeholder-driven priority setting. Two case studies from separate geographies and components of the PacIOOS program illustrate

the value of this stakeholder-driven approach for an effective regional ocean observing system.

Pacific Islands Ocean Observing System Regional Geography and Effort

PacIOOS sustains ocean observations within the State of Hawaii, the territories of Guam, the Commonwealth of Northern Mariana Islands (CNMI), American Samoa, the Freely Associated States of the Federated States of Micronesia (FSM), the Republic of the Marshall Islands (RMI), the Republic of

Palau, and the Minor Outlying Islands of Howland, Baker, Johnston, Jarvis, Kingman, Midway, Palmyra, and Wake (Figure 1). In addition, PacIOOS develops and maintains numerical models and forecasts, collects ocean data and information from partners across the region, integrates the information into freely accessible data services, and places it all in user-friendly web interfaces and online tools for consumption by users of all levels.

PacIOOS' ocean observations are composed of a variety of instrumentation and infrastructure to meet programmatic goals and stakeholder needs supporting four main focus areas: water quality, marine operations, ecosystems and living marine resources, and coastal hazards. The goals and priorities for each of these focus areas guide the strategic plan and are set through an iterative, participatory engagement process with stakeholders, which is described in more detail below.

Regional Challenges

As with all regions, the stakeholders in the Pacific Islands are diverse, and personal relationships and on-the-ground experience are vital. The sheer expanse of the Pacific Islands region makes this a challenge. The region “covers a vast area of the globe—spanning six time zones across the Pacific Ocean...is bisected by the International Date Line, straddles all four hemispheres, is distributed over an area of nearly 35 million km² including 2,500 km of coastlines, and over 2,300 individual islands” (PacIOOS, 2012). The logistics and costs associated with running a program encompassing such a vast geographic area are understandably high, especially with regard to maintaining distributed observing equipment, supporting effective communication channels, and cultivating lasting and meaningful relationships. The challenges associated with the size of the region are not insurmountable, but

they necessitate innovative and flexible solutions.

In addition to size, the Pacific Islands region faces disparities of economies, technical capacity, and training. There are numerous languages, cultures, and customs to work within. U.S. federal involvement also varies across the region based on political status, limiting opportunities for leverage and collaboration on such scales. Significant for ocean observing systems, there are major differences within the region related to data and data access. Like other RAs with large spatial footprints, the region must cope with an unacceptable lack of data and resources. Even when data are available, access is often an issue. While smartphones have permeated throughout much of the Pacific Islands, many island territories and nations in the PacIOOS region struggle with limited bandwidth, and Internet access and home computers are the exception rather than the norm. In the digital age, when most PacIOOS products are only available online, this reality significantly affects the ability of potential constituents to consume information the program provides, thereby increasing the challenge to facilitate positive impact in this region.

FIGURE 1

The PacIOOS region includes the state of Hawaii, the territories of Guam, the CNMI, American Samoa, the Freely Associated States of the FSM, the RMI, the Republic of Palau, and the Minor Outlying Islands of Howland, Baker, Johnston, Jarvis, Kingman, Midway, Palmyra, and Wake. Map courtesy of PacIOOS.



Stakeholder-Driven Priority Setting

For many parts of the region, it is challenging to identify cost-effective and feasible ways to have impact and provide value to stakeholders. In order to affect the greatest benefit to the region, it is imperative for PacIOOS to approach stakeholder engagement strategically.

Identifying PacIOOS Stakeholders

“Although each of the island constituents in the PacIOOS region is

distinct in terms of their respective governments, languages, legal systems, geographical setting, cultural norms, societal structure, economies, and level of infrastructure, all are uniquely tied to the ocean” (PacIOOS, 2012). Users for ocean observing products are found in all levels of government, the ocean recreation and commerce sector, the hotel and tourism industry, media, locals, visitors, and nongovernmental organizations.

Based on years of experience working closely with stakeholders during large stakeholder meetings, focus groups, and one-on-one discussions, the PacIOOS management team determined that ocean observing stakeholders can be categorized into four general groups for the purpose of delineating levels of engagement: (a) data super users, (b) industry and natural resource managers, (c) informed public ocean users, and (d) the general public (Figure 2).

Data super users are stakeholders with a high rate of data consumption and a high knowledge base related to ocean data. This group tends to include scientists, graduate students, and industry professionals who build and consume products or are hired as consultants for project-specific work. Stakeholders in this group do not require extensive engagement for several reasons. First, while they use a lot of data, it is often for discrete projects, so their needs are not consistent. Second, they are typically very capable and knowledgeable about how to locate required data. If they cannot find it on their own, they will ask for it. Finally, because their data needs are high and inconsistent, they do not tend to be loyal to any particular data provider. The availability of the data they need is more important than ease of discovery or access. An example data super user is a metocean engineer contracted by an

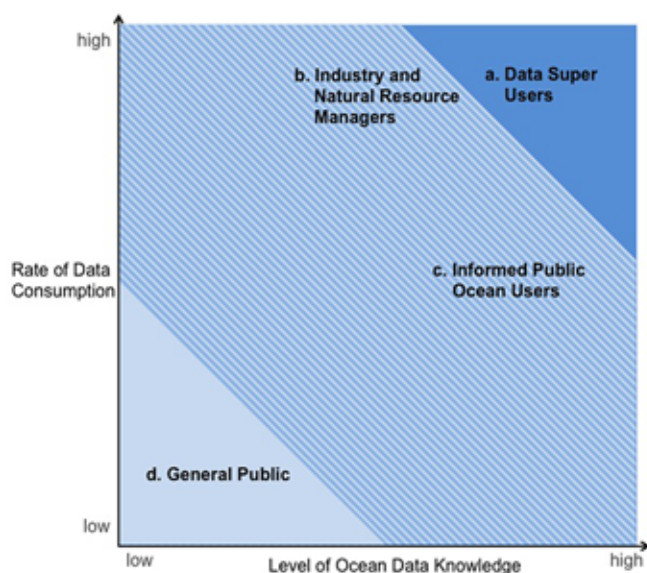
oil refinery to conduct a commercial study to establish the occurrence of various speed/heading combinations at an offshore terminal for their oil tankers. When the engineer was not able to find the exact data set he needed for the job, he contacted PacIOOS directly to request all of the historical, quality-controlled surface current data offshore of the refinery.

The second group, industry and natural resource managers, are stakeholders who tend to have high data consumption and a relatively high knowledge base related to ocean data, but less so than their data super-user counterparts. This group often includes industry employees, government agency resource managers, nongovernmental conservation groups, commercial fishermen, and so forth. These are folks whose professions rely on, or are related to, ocean data and information, so their dependency and therefore consumption of data is high (e.g., a tugboat captain may look at wave buoy data several times a day, before each operation he performs). Often, however, these stakeholders have many other responsibilities and limited time to seek out the required data on their own—some assistance may be needed to locate the desired data. Examples of the types of questions these stakeholders ask are as follows: Is it safe to enter the harbor? Are conditions right to do a coastal survey today? Are the mechanisms we are using to decrease sedimentation on coastal coral reefs effective?

Ocean recreationists such as surfers, paddlers, boaters, recreational fishermen, and ocean enthusiasts can be described as informed public ocean users. This group has a medium to high data knowledge but relatively low data consumption rates (e.g., checking data from one wave buoy two to three times a week). They often know what type

FIGURE 2

PacIOOS stakeholders are categorized by their level of ocean data knowledge and their rate of data consumption. Groups (b) industry and natural resource managers and (c) informed public ocean users fall within the middle of the grid, in the hashed area. These groups generally have consistent data needs and the capacity to utilize the data; therefore, PacIOOS focuses engagement on stakeholders who fall within these two categories.



of data they want but not necessarily where to find it, and their data consumption rates are often inconsistent, based on the season and other non-ocean-related natural and personal factors. Stakeholders in this group tend to need information to determine optimal times and locations for activities based on ocean conditions. Examples of the types of questions they ask include as follows: Should I swim or surf today? Where? What route should I take? Is it safe and economical to go fishing today?

The general public group includes occasional and non-ocean users and tourists. These stakeholders typically have low data consumption rates and low ocean data knowledge, meaning they often do not know what type of data they need or where to locate it. Sometimes, users in this group wander into the higher data consumption rates due to external influences (e.g., viewing numerous tiger shark tracks in one day during Shark Week) but not on a consistent basis. This group is quite large and diverse.

While individuals can and often do fit within more than one group, or move between the groups, the divisions described above provide a useful screening tool to maximize the effectiveness of PacIOOS outreach and engagement efforts. Furthermore, although all people in the region can stand to benefit at least indirectly from ocean observing efforts, the realistic level of direct positive impact PacIOOS can provide is determined by targeting users based on their rate of data consumption and their level of ocean data knowledge. While both the data super users and the general public benefit from ocean observing efforts, they have inconsistent needs that are either too narrow or too broad to effectively and efficiently target

them with PacIOOS' limited outreach and education resources. However, these stakeholders are otherwise engaged in PacIOOS through various researcher-level collaborations, professional meetings, university classes and seminars, projects, and partner outreach events; therefore, they still inform program priority setting.

Compared with data super users and the general public, industry members, natural resource managers, and informed ocean users generally have consistent data needs and the existing capacity to utilize the data. While these users have different modes of operation and decision making, they have similar drivers for their data needs. Engaging with them has the greatest potential to result in outcomes that are mutually beneficial. For the past eight years, the researchers and experts affiliated with PacIOOS have employed this strategy of balancing data needs and ability to use information to successfully identify and engage local stakeholders. The stakeholder-driven priority setting process detailed in the next section has also served to increase stakeholder benefits in a timely, flexible, and effective fashion.

Identifying and Prioritizing Stakeholder Needs

PacIOOS was developed upon the foundation of a diverse yet focused and closely connected ocean community. As a result, who the system is designed for is always at the forefront of PacIOOS administrators and staff. However, in such a large region with myriad and often conflicting ocean interests, having stakeholder needs drive the priority setting process is not a simple task. When strategically developing PacIOOS, the team systematically sought out cross-sectional input from across the region in order to design a

system that would be relevant to local ocean data needs. In the process, a wide range of user groups was identified and actively engaged to initially define, and now continuously refine, the system. The importance of this input is highlighted in the PacIOOS Strategic Operational Plan 2013–2018: “The continued success of PacIOOS relies on forging strong partnerships, maintaining an engaged, informed and interactive user base, consistently addressing user demands for data and products, and maximizing the effectiveness of our products and services” (PacIOOS, 2012).

Initial engagement was extensive, both geographically and programmatically, including many levels of federal, state, and local/regional government, the ocean recreation and commerce (fisheries, transportation, offshore energy) sectors, the hotel and tourism industry, and nongovernmental organizations. Input was gathered at community, agency, and personal meetings, through review of needs assessments written at various scales, and via focus group discussions.

When determining the initial constellation of core PacIOOS staff, user outreach and engagement was identified as a key component in order to ensure a continuous feedback loop to maintain relevancy in the region. The PacIOOS communications and program coordinator position was specifically created to take on this responsibility. However, PacIOOS recognized that one person based in Honolulu, Hawaii, could not effectively garner all of the stakeholder feedback necessary to keep the program relevant and in-tune with needs from all jurisdictions within the region. While visits to the various locations in the region by Honolulu-based PacIOOS staff are effective and certainly essential to

maintain relationships with stakeholders, having staff based throughout the region is also crucial for successful stakeholder engagement.

To build place-based capacity, PacIOOS also hires and contracts liaisons to manage extension and stakeholder engagement work outside Hawaii. Liaisons are located in Guam, the FSM, the Marshall Islands, and American Samoa. The liaisons ensure regular engagement, stakeholder feedback, and input into the short-term annual priority setting as well as the long-term strategic planning. Input is gathered at community and in-person meetings, workshops, training sessions, and focus groups; through Webinar and Web-based feedback services; and through review of strategic plans, prioritization documents, and needs assessments compiled by partner organizations.

In addition to ongoing and regular contribution to needs assessments, gap identification, and priority identification, stakeholders can choose to participate in higher-level priority adoption and planning through the PacIOOS governance framework. Stakeholder groups and organizations (see Figure 2, group (b): industry and natural resource managers) are invited to become formal partners with PacIOOS by signing a Memorandum of Agreement (MOA). It is through the MOA signatories that the PacIOOS Governing Council members are nominated and elected. MOA signatories populate electing cohorts (i.e., regional partners, Hawaii-specific partners, Palau-specific partners), each of which votes to determine their representative(s) to the Governing Council.

Council members provide general oversight and policy guidance, adopt implementing documents and strategic plans, and advise on major decisions and partnerships for PacIOOS.

The Council works with PacIOOS staff through annual meetings, individual discussions, and a five-member Executive Committee to review region-wide needs and priorities from all stakeholders and to determine annual guidance to the program on implementation as well as long-term strategic planning.

This region-specific model of representative democracy helps ensure that all formal partners of PacIOOS have a means for participation and a system within which they can express their views on priorities, actions, and investments. Presidential and governor-level appointees to the PacIOOS Governing Council are a testament to the credibility of the system within the broad stakeholder community, as is the distribution of Council members from within various important regional sectors (academic, government, tourism, industry, defense, conservation), the consistent increase in partners to the organization through adoption of the MOA, and the sustained growth in users and providers of information to the observing system.

Results of the strategically designed PacIOOS stakeholder engagement reveal consistent requests for focused, innovative, and highly accurate products to support decision making, planning, and user safety. There is a widespread desire to better understand the ocean environment, providing the foundation from which to build an effective ocean observing system that can truly make a difference in the lives of PacIOOS constituents.

By continuously assessing the needs, gaps, solutions, and capabilities in the region through multifaceted communications with diverse stakeholders, PacIOOS designed and continues to prioritize efforts largely based on two principles: (a) degree of information

need and (b) potential for PacIOOS to affect positive impact. Described below are two case studies that illustrate the high impact and the tangible benefit to stakeholders resulting from this engagement strategy of targeting specific groups within the larger stakeholder community.

Case Study: Forecasting Wave Inundation to Save Lives and Protect Property in the Marshall Islands

In March 2014, the RMI government declared Majuro and other atolls to be in a state of emergency due to a severe flooding event that caused the evacuation of almost 1,000 people. The NOAA National Weather Service (NWS), RMI Weather Service Office explained that inundation events in the RMI from sea swells were more frequent than in recent years. Instead of experiencing such events once every 14–15 years, Majuro was enduring several in one year. As a result, communities, homes, businesses, and general infrastructure are increasingly impacted by wave activity and inundation. The RMI is composed almost entirely of low-lying atolls and is therefore highly vulnerable to flooding. With a population density of 7,413 per square mile (Secretariat of the Pacific Community, 2012), Majuro is particularly vulnerable.

Since 2012, PacIOOS has offered a high sea-level forecast for Majuro (and other locations in the Pacific) to predict higher-than-normal sea levels that could result in potential coastal flooding. The PacIOOS Six-Day High Sea Level Forecast provides a more accurate analysis of short-term sea levels than similar tools by incorporating several nontidal components of sea level variability, such as eddies and currents. Swell events, however, are not ingested into these forecasts.

After the March 2014 event, the Marshall Islands representative on the Governing Council and the local PacIOOS liaison relayed stakeholder needs from the RMI government, the College of the Marshall Islands, non-profit organizations, and numerous individuals to the PacIOOS management team, asking if anything could be done to provide better warning of such events. After consulting with PacIOOS research collaborators, the team determined that enough was known about the reefs and the wave energy transfer on Majuro (Merrifield et al., 2014) to build upon the existing PacIOOS Six-Day High Sea Level Forecast for Majuro. Using established high-resolution bathymetry and LIDAR mapping of the coastal zone, a wave run-up forecast was developed. This more advanced forecast accounts for empirical relations and offshore swell wave directional spectrum forecasts for the next six days to predict when it is likely that there will be wave overtopping along the coast.

PacIOOS management had to determine whether to divert efforts to Majuro or continue refining an existing wave run-up forecast for the North Shore of Oahu, Hawaii. The high need and the strong potential to benefit stakeholders made it a relatively straightforward decision. Resources were quickly redirected to support the development of the PacIOOS Majuro Wave Run-Up Forecast. Although the refinement of the North Shore Wave Run-Up Forecast was also important, PacIOOS remained cognizant of the need to be responsive as opportunities and needs arise. Furthermore, while the refinements planned for the North Shore forecast would enable more detailed and accurate forecasts along various locations of the Oahu coastline, the existing tool

provided a degree of notice and information that the communities on Majuro did not yet have. In addition, development of a Majuro forecast tool could benefit Kwajalein, another atoll in the Marshall Islands that was also experiencing more frequent inundation events. After the Majuro forecast tool was completed, the team could both expand to include a forecast tool for Kwajalein and resume work on the Oahu forecast.

The new Majuro forecast tool was launched in October 2014, seven months after the event that roused concern and requests to PacIOOS. The tool updates hourly and provides a forecast of high sea level and potential wave run-up for ocean-facing shorelines for the upcoming six days. In January 2015, the Majuro Wave Run-Up Forecast predicted a series of potential flooding events for the upcoming days (Figure 3). Indeed, ocean-facing shorelines experienced wave inundation and houses were flooded, clearly emphasizing the urgent need and utility for the wave run-up forecast. Ample lead

time provided by the forecast not only protected lives but also enabled government agencies and residents to proactively build temporary berms to minimize damage to community infrastructure and personal property.

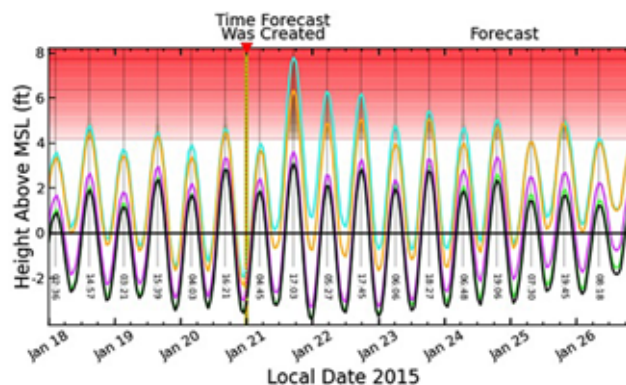
PacIOOS has since refined the Majuro forecast tool to better meet community needs by working with local partners to ground-truth the data and to obtain feedback. Based on this information, usability and readability were improved. The U.S. Embassy on Majuro, RMI government agencies, NWS RMI Weather Service Office, and nonprofit organizations consult the PacIOOS wave run-up forecast daily. The PacIOOS liaison also monitors the forecast and sends notices if the forecast suggests potential for inundation.

Case Study: New Wave Buoys Deployed to Save Lives in the Mariana Islands

The dangers of rapidly changing ocean conditions in the Pacific Islands are severe. Calm, low-surf, sunny days

FIGURE 3

PacIOOS Wave Run-Up Forecast for Majuro, RMI. The four colored curves show the inundation height for four different ocean-facing shorelines of the most populated atoll in the Marshall Islands. The potential for inundation of the land is forecasted due to high tides and/or nonlocal wind-generated waves. If the forecast inundation height extends into the red shaded area, inundation is likely in low-lying areas. For the 3 days before the “Time Forecast was Created,” the colored curves show the last valid forecast for each date/time. The forecasts are updated hourly and are available online at http://pacioos.org/data_product/SLpred/Maj_Exc.php.



can quickly turn to high-surf conditions causing inundation and dangerous ocean conditions for unaware ocean users. Without advance notice of the changing conditions, beachgoers are caught off guard and cannot react in time to the high surf and strong rip currents. Sadly, some people have drowned when these life-threatening conditions develop, including a teenage boy who died at Ritidian Point on the northwest tip of Guam in June 2012.

In an effort to improve the safety of beachgoers and avoid future injuries and loss of life, NOAA's NWS Guam strongly advocated for PacIOOS to deploy additional Datawell Directional WaveRider buoys (Figure 4) in the region. PacIOOS broadened the discus-

sion to include the Guam and CNMI Governing Council representatives and the local liaison, who all had strong connections with local recreational fishermen and other ocean users (see Figure 2, group (c): informed public ocean users). Other stakeholders from group (b) were brought into the conversation as well, including members of the U.S. Coast Guard who conduct search and rescue missions in the territories. It quickly became clear to all involved that real-time wave information would benefit a range of ocean stakeholders in both Guam and Saipan, the main island in the CNMI. Ritidian Point was a common point of interest for all stakeholders in Guam. In addition, a similar site off

Saipan would benefit both the NWS and Saipan ocean users.

PacIOOS responded. A new wave buoy was deployed off Ritidian Point, Guam, on October 20, 2012. Another one was moored off Tanapag, Saipan, on October 24, 2012. Both PacIOOS wave buoys provide real-time data on wave height, wave direction, wave period, and sea surface temperature. NOAA Coastal Storms Program provided funding to purchase both buoys. Data streaming from the buoys is made possible through long-term partnerships with the Coastal Data Information Program at Scripps Institution of Oceanography and the U.S. Army Corps of Engineers.

In late January 2013, the value of the PacIOOS wave buoys was demonstrated with the arrival of large north swells to the islands. PacIOOS wave buoys allowed the NWS to produce accurate, high-surf forecasts and advisories that warned the public of the coming hazard. For that event, inundations of 1–2 feet were predicted on north and northwest exposures—presenting a significant risk to beachgoers. Once the advisories were issued, NWS Guam spread the word via their Web site, social media, NOAA Weather Radio (available in Mariana Islands by dialing 211), local radio and television stations, local newspapers, and live interviews. The public was well informed; residents and visitors had time to prepare for the impending hazard. NWS monitored the swell (average wave height, maximum height, direction, and period) arriving via the PacIOOS wave buoys in Tanapag, followed by Ritidian Point (Figure 5). The forecasters witnessed the swell as high surf at Paseo Park, a popular surfing and recreational area with northern exposure in Hagatna, Guam's capital city. With advanced warning for Guam and

FIGURE 4

Image of a PacIOOS-funded Datawell Directional WaveRider buoy in the PacIOOS region. These buoys report wave height, wave direction, wave period, and sea surface temperature every 30 min. (photo credit: PacIOOS)

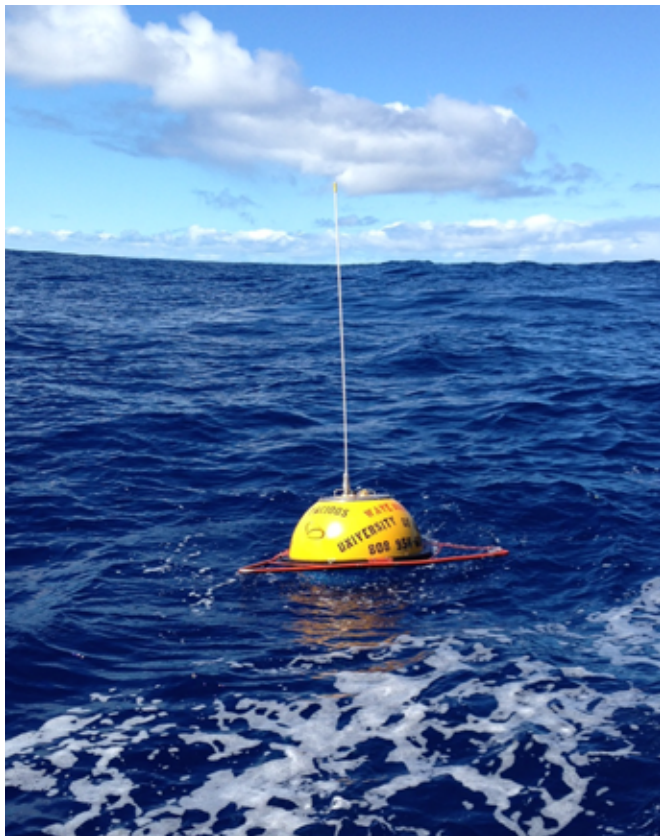
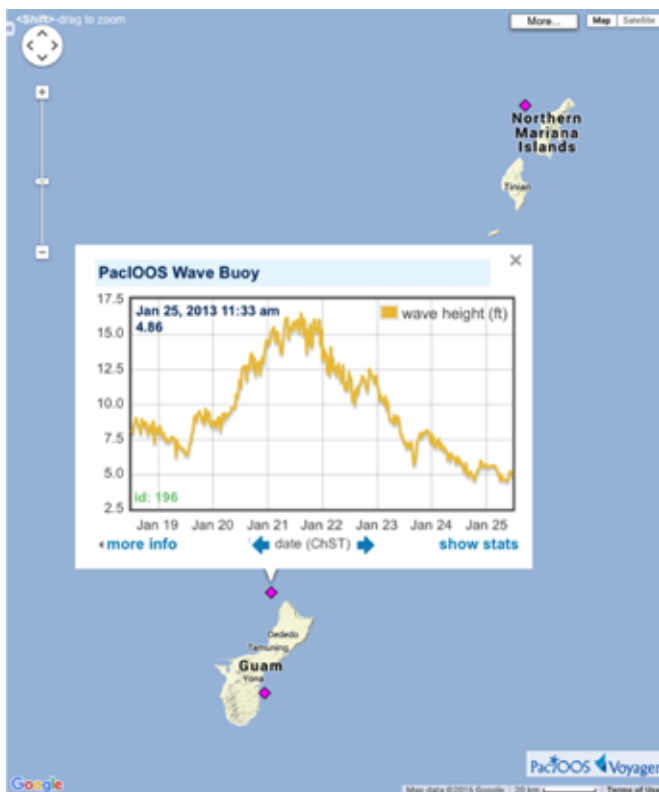


FIGURE 5

The locations of PacIOOS wave buoys around Guam and the Northern Mariana Islands are indicated by purple diamonds. A pop-up showing the wave height data reported by the Ritidian Point wave buoy indicates ocean swells approaching 17 feet in late January 2013.



Rota beachgoers, no one was injured, despite the large north swell event.

Event-driven forecasts are one benefit of the wave buoys. Regular use by a cadre of users is also of great value. The U.S. Coast Guard, local fishermen, surfers, tour companies, and others all use the data provided by the PacIOOS wave buoys to routinely make informed decisions. In November 2015, the National Data Buoy Center received more than 37,000 data requests for the two buoys, clearly emphasizing the value of data from these buoys to diverse stakeholders in the region.

Summary

The stakeholder-driven priority setting approach employed by PacIOOS

has proven to be effective, as demonstrated in the two case studies above. In addition, both case studies illustrate how responding to agencies and informed ocean user needs can address the needs of another stakeholder group—the general public. Although the general public may not have known such data needs existed, the agencies and informed ocean users were able to articulate the drivers so that PacIOOS could determine how to respond in a manner that resulted in high benefit to a large and diverse group of stakeholders. By putting assets and systems in place, PacIOOS provides its partners and users with the data and information needed to achieve their missions to safeguard life and property, increase resiliency,

and improve on-the-ground decision making.

While PacIOOS cannot engage with all ocean stakeholders in the vast region under its purview, the strategic approach employed to identify, engage, and respond to stakeholders in the U.S. Pacific Islands serves as an effective and efficient manner to ensure that both specific ocean stakeholders and stakeholders, writ large, benefit from the resources and efforts put forward to advance ocean observing in the region.

Corresponding Author:

Melissa M. Iwamoto
Pacific Islands Ocean Observing
System and School of Ocean and
Earth Science and Technology,
University of Hawaii at Manoa
1680 East West Road, POST 815D,
Honolulu, HI 96822
Email: Melissa.Iwamoto@hawaii.edu

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